



Research Journal of
**Environmental
Sciences**

ISSN 1819-3412



Academic
Journals Inc.

www.academicjournals.com

Chemical Analysis of Some Industrial Effluents That Discharge into Lagos Lagoon, Nigeria

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Abstract: Effluent from two different companies Afprint (textile) and Nigeria Breweries Plc. that discharge into Lagos Lagoon were collected at different drainage channels and analysed for physico-chemical parameters and heavy metals. The level of the physico-chemical parameters considered such as pH, alkalinity, biological oxygen demand, chemical oxygen demand, dissolve oxygen and alkalinity were very high. Nigeria breweries effluent had the highest values of most of these parameters. Heavy metals like Mn, Pb, Cd, Cr, Fe and Cu were present in all the effluents from the companies. Cu, Zn, Mn, Pb and Fe were the most common heavy metals in all the effluents while Cr was found consistently in textile effluents. The Fe in Brewery's effluent doubles that of textile's effluent. There was decreasing concentration of some metals (Fe, Cu, Cd, Mn, Cr, Zn, Mn, Pb, Cr, Cu and Hg) from their source towards the Lagoon.

Key words: Effluents, Lagos Lagoon, brewery, heavy metals, textile, industry

INTRODUCTION

Heavy metals are vital source of pollution not just because they are toxic above a relatively low concentration but also because they are persistent, remaining in the environment long after the source of pollution has been removed (Voutsinou-Taliadouri, 1981). Lori (1991) identified effluents from textile industries in Nigeria as one of those introducing heavy metals along with other pollutants into the environment. The rate of heavy metal pollutants into natural waters in Nigeria is therefore still largely unknown (Oyewo, 1998).

According to Aina and Adedipe (1992), waste treatment in majority of the industries is virtually non-existent. Only a few industries have installed the simplest pollution control equipment such as sedimentation, sand filtration or oil and grease traps for effluents scrubbers and particulate traps or precipitators for gaseous emissions. Regrettably, most of the treatment facilities where they exist are grossly inadequate to cope with the volume and type of waste generated. Others are poorly maintained or have broken down completely. In short, what we have today, as treatment facilities are environmentally unacceptable (Aina, 1992).

The Lagos Lagoon complex is the largest lagoon systems of the Gulf of Guinea coast in West Africa (Hill and Webb, 1958). This lagoon system borders the rain forest belt and receives a number of major rivers and streams. In Nigeria over 85% of all industries are situated in Lagos metropolitan area (Portman *et al.*, 1997) and their effluents ultimately get into the Lagos Lagoon complex directly or indirectly via drainages or streams and pollute the nursery grounds of both fishes and shrimps (Oyewo, 1998; Solarin, 1998). In Nigeria, measures for scheming pollution of coastal waters are relatively recent and there is inadequate baseline data on which to base appropriate management practices. The aim of this study therefore was to determine the heavy metals in some industrial effluents that discharge into Lagos Lagoon.

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MATERIALS AND METHODS

Study Area

Lagos Lagoon lies between longitudes 3° 22' E and 3° 40' E and Latitude 6° 17' N and 6° 28' N. The lagoon is generally shallow with a depth of between 0.3 and 3.2 m in most parts with the exception of some dredged parts, notably in the Lagos Harbour, where depth is greater than 10 m. The tidal range is 0.3-1.3 m.

Effluent Collection

Twenty five liters containers were used for the collection of the effluent sample. The effluents were collected in 2005 from two companies with outlets into Lagos Lagoon. These companies are Afprint Nigeria Ltd., (Textile) and Nigeria Brewery PLC (Brewery) all located at Iganmu Industrial area of Lagos.

The collection sites were designated A, B and C

- A : Point of outlet from the company into the Lagos Lagoon
- B : Five hundred meters away from A along the drainage channel
- C : One thousand meters away from A along the same drainage channel.

Control-water from Badore-Aja end of the Lagos Lagoon was taken as the zone was reported (Oyewo, 1998) to be free of effluent entry.

Chemical Analysis of Effluents

Temperature of the effluents were taken by immersing a mercury in-glass thermometer directly in the 25 L container used in collecting the effluent immediately after collection before leaving the site. Alkalinity was estimated titrimetrically using 0.02 NH_2SO_4 with phenolphthalein and methyl orange as indicator.

pH, conductivity, turbidity and salinity of the effluent samples were determined using Horiba water checker model U-10.

Dissolve Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), total hardness, hydrogen sulphide, oil/grease and residual/free chlorine were determined using standard methods as described in Global Environmental Monitoring System of WHO (1987).

Cadmium (Cd), Iron (Fe), Chromium (Cr), Copper (Cu), lead (Pb) and manganese (Mn) in the effluent samples were assayed using Atomic Absorption Spectrophotometer (AAS) model Unicam Solar Spectrometer 969V5.24. Fifty milliliters of each sample was used for the analysis. Standards were prepared from 1000 mg L^{-1} stock solution of the different metals of interest. Serial dilutions were made to obtain 1.0, 2.0 and 3.0 mg L^{-1} . The equipment was calibrated using deionized water as blank.

RESULTS AND DISCUSSION

The colors of the effluents at the points of entry into the drainage channels varied. The physico-chemical parameters such as temperature, pH etc. differs (Table 1).

That most Nigeria industries discharge their untreated effluent through drain or canals into the nearest water body e.g., streams, rivers, estuaries, lagoon and sea as observed by Portman *et al.* (1989) and Aina (1992) was confirmed in this study as all the effluent used for the tests was collected from the drainage channels.

Table 1: Physico-chemical parameter of the effluents

Company	Location	Temp	pH	Conductivity	Turbidity	Salinity	Alkalinity	Total
		(°C)		($\mu\text{mh cm}^{-1}$)			(mg L^{-1})	hardness
Afprint	A	27	7.62	798	28	0.2	1000	1400
	B	28	7.63	755	4	0.1	700	1200
	C	28	7.63	730	3	0.1	600	1100
NB Plc	A	31	5.03	1140	545	0.5	200	5000
	B	30	4.92	1170	606	0.5	115	3750
	C	30	4.50	1160	570	0.5	130	3500

Company	Location	Residual	Total	Oil/	BOD	COD	H ₂ S	DO ₂
		free Cl ₂	suspended solid	grease	(mg L^{-1})			
Afprint	A	0	400	0.0	602	992	20.00	0
	B	0	320	20.0	580	840	15.20	0
	C	0	240	0.0	420	720	16.50	0
NB Plc	A	0	950	0.0	1637	2410	120.00	0
	B	0	800	0.0	1240	2200	140.00	0
	C	0	750	0.0	1180	2150	130.00	0

Table 2: Level of heavy metals in the effluents

Company	Location	Heavy metals (mg L^{-1})					
		Mn	Pb	Cd	Cr	Fe	Cu
Afprint	A	0.509	ND	ND	0.746	0.960	0.178
	B	0.511	0.469	ND	0.091	ND	0.091
	C	0.392	ND	ND	0.526	ND	0.052
NB Plc	A	0.602	ND	ND	0.364	1.963	0.136
	B	0.536	ND	ND	0.291	2.064	0.083

ND = Not Detected

The constituents investigated for each of the companies' effluents shows the presence of heavy metals like manganese, lead, cadmium, chromium, iron and copper (Table 2). The occurrence of these heavy metals in the effluents of Afprint (Textile) and Nigeria Breweries (Brewery) is in agreement with the earlier investigations of FMHE (1983), Lori (1991) and Ayodele *et al.* (1991). The level of the physico-chemical parameters considered such as pH, alkalinity, biological oxygen demand, chemical oxygen demand, dissolve oxygen and alkalinity were very high. It is noteworthy that Nigeria breweries effluent had the highest values of most of these parameters.

The iron (Fe) in Brewery's effluent doubles that of textile's effluent. These could be due to the higher levels of Chromium in Afprint (textile) effluent compared with the Nigeria brewery effluent and probably.

In the FMHE (1983) monograph, a description of types and concentrations of heavy metals in the analyzed effluents from various industries located all over Nigeria showed that Cu, Zn, Mn, Pb and Fe were the most common heavy metals in all the effluents while Cr was found consistently in textile effluents. Lori (1991) had also identified effluents from textile industries in Nigeria as one of those introducing heavy metals along with other pollutants into the environment. All these were confirmed in this study. While Oyewo (1998) observed an increasing concentration of some metals (Fe, Cu, Cd, Mn, Cr, Zn and Hg in the wet season only) in most cases away from discharge points towards the point 2000 m away from discharge and next to the lagoon, this study showed the reverse, though the observation in this study is also in agreement with another observation of Oyewo (1998) where he noted that some metals (Mn, Pb, Cr and Cu) showed a recognizable gradient decreasing away from their source towards the lagoon. A comparison of water column and sediment metal levels by Oyewo (1998) showed that in all cases, the measured level in the water column were less than those measured in the bottom sediments by varying orders of magnitude ranging from 40-23,766 folds. Only the water

column of the channel was considered in this study. Other studies in which higher concentration were found in the bottom sediment than in the corresponding water column include those of Patel *et al.* (1985) on Bombay harbors, Okoye (1989) on Lagos Lagoon and Chukwu (1991) on Sasa river. The values of the heavy metals observed in this study were lower than the values reported by Akinola *et al.* (1981) and Lori (1991), this could be an indication that the industries are taking to the guidelines and standards of FEPA which is charged with the responsibilities of protecting the environment.

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